Shaping both Light & Material for Optimal LightMatter Interaction.

Glückstad, Jesper

Publication date:
2014

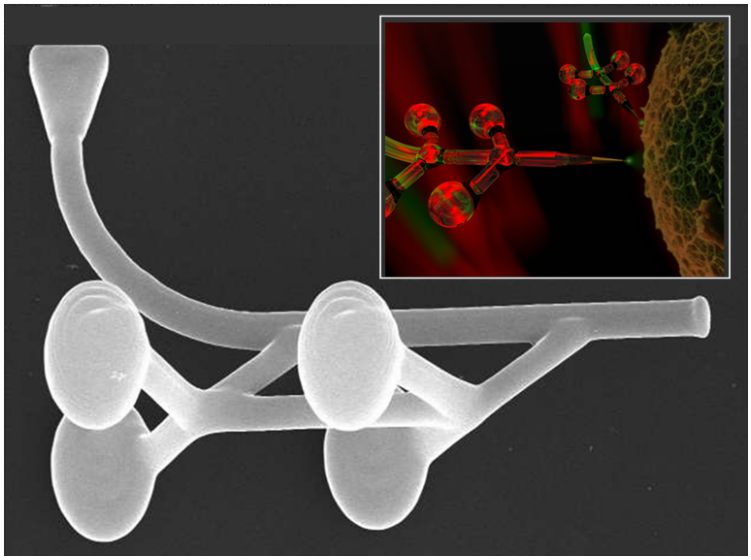
Document Version
Publisher's PDF, also known as Version of record

Shaping both Light & Material for Optimal Light-Matter Interaction

J. Glückstad
DTU Fotonik, Dept. of Photonics Engineering,
Technical University of Denmark,
DK-2800 Kgs. Lyngby, Denmark

jesper.gluckstad@fotonik.dtu.dk
www.ppo.dk www.optorobotix.com

The sci-fi inspired miniaturization of full-scale robotic manipulation down to the mesoscopic scale regime opens new doors for exploiting the forces of photons for micro- and nanobiologic probing, actuation and control [1-3]. A generic approach for optimizing light-matter interaction on these scales involves the combination of optimal light-sculpting [4] with the use of optimized shapes in micro- and nano-robotic structures [5]. Micro-fabrication processes such as two-photon photo-polymerization offer three-dimensional resolutions for crafting custom-designed monolithic microstructures that can be equipped with optical trapping handles for convenient opto-mechanical control using only optical forces [6].



Such microstructures - as illustrated above - can be effectively handled with simultaneous top- and side-view on our proprietary BioPhotonics Workstation (BWS) to undertake six-degree-of-freedom optical actuation of tiny 3D-printed tip-structures easily entering the submicron-regime. Aided by our international collaborators who fabricated test structures for us, we were able to put our pioneering concept of optically steerable freestanding waveguides – coined: wave-guided optical waveguides - to the test using our BWS [7]. We have also proposed using these techniques for generating two-photon real-time spatially sculpted light for the strongly emerging areas of neurophotonics and optogenetics [4].

[1] P. Rodrigo, L. Kelemen, D. Palima, C. Alonzo, P. Ormos, and J. Glückstad, "Optical microassembly platform for constructing reconfigurable microenvironments for biomedical studies," *Optics Express* 17, 6578-6583 (2009).

[2] J. Glückstad, “Sorting particles with light,” *Nature Materials* 3, 9-10 (2004).

[3] J. Glückstad, “Optical manipulation: Sculpting the object,” *Nature Photonics* 5, 7-8 (2011).

[4] E. Papagiakoumou, F. Anselmi, A. Begue, V. de Sars, J. Glückstad, E. Isacoff, V. Emiliani, “Scanless two-photon excitation of channelrhodopsin-2,” *Nature Methods* 7, 848-854 (2010).

[5] D. Palima, A. R. Bañas, G. Vizsnyiczai, L. Kelemen, P. Ormos, and J. Glückstad, "Wave-guided optical waveguides," *Opt. Express* 20, 2004-2014 (2012).

[6] D. Palima and J. Glückstad, “Gearing up for optical microrobotic manipulation: mechanical actuation of synthetic microstructures by optical forces,” Laser & Photonics Reviews 7, 478-494 (2013).

[7] H. Ulriksen, J. Thøgersen, S. Keiding, I. P.-Nielsen, J. Dam, D. Palima, H. Stapelfeldt, J. Glückstad, "Independent trapping, manipulation and characterization by an all-optical biophotonics workstation," *J. Eur. Opt. Soc-Rapid* **3**, 08034 (2008).

Brief biography

Prof. Jesper Glückstad established the Programmable Phase Optics www.ppo.dk in Denmark more than a decade ago and currently holds a position as Professor at DTU Fotonik, Dept. of Photonics Engineeering at the Technical Univ. of Denmark, and a position as Guest Professor in Biophotonics at Lund Institute of Technology, Sweden. In 2004 he received the prestigious Doctor of Science (DSc) degree from the Technical University of Denmark for the dissertation entitled "The Generalised Phase Contrast method". Together with a colleague he has authored a Springer book on this topic published in the fall 2009. Prior to his achievements in Denmark, Prof. Glückstad was a visiting scientist at Hamamatsu Photonics Central Research Laboratories and in the Physics Dept. at Osaka University in Japan. Since he obtained his PhD at the Niels Bohr Institute in 1994, he has published more than 250 journal articles and international conference papers and holds more than 25 international patents and patent applications. He has published papers in *Nature Materials, Nature Methods and Nature Photonics*. He is the year 2000 recipient of the Danish Optical Society Award and was elected as «Scientist of the Year» in 2005 by the Ib Henriksens Foundation in Denmark. Prof. Glückstad is a 2010 elected Fellow of the OSA and a Fellow of the SPIE as the only from Denmark. In 2012-2014 he is appointed for the prestigious SPIE Fellows committee. In 2013 he will be joining the Editorial Board of JEOS. Most recently he founded the DTU start-up OptoRobotix originally spun out in Silicon Valley, CA, i.e. www.optorobotix.com